Recent Research – TRB Compendium of Papers 2006

Life Cycle Cost Analysis of SMA Pavements and SMA Application Guidelines
WHRP Project 0092-04-06

The paper(s) abstracted below report recent research that may be related to the subject matter or methodologies of this WHRP project. For access to the CD-ROM and full text of the paper, contact Hussain Bahia (bahia@engr.wisc.edu) or Greg Waidley (gwaidley@engr.wisc.edu) at WHRP or John Cherney (john.cherney@dot.state.wi.us) at the WisDOT Library.

Characterization of Aggregate Resistance to Degradation in Stone Matrix Asphalt Mixtures
Paper No. 06-2562
Authors: Dennis Gatchalian, Eyad Masad, Arif Chowdhury, Dallas Little
Abstract: Stone Matrix Asphalt (SMA) mixtures rely on stone-on-stone contacts among particles to resist applied forces, and permanent deformation. Aggregates in SMA should resist degradation (fracture and abrasion) under high stresses at the contact points. This study utilizes conventional as well as advanced imaging techniques to evaluate aggregate characteristics and their resistance to degradation. Aggregates from different sources and types with various shape characteristics were used in this study. The Micro-Deval test was used to measure aggregate resistance to abrasion. The aggregate imaging system (AIMS) was used to examine the changes in aggregate characteristics caused by abrasion forces in the Micro-Deval. The resistance of aggregates to degradation in the SMA was evaluated through the analysis of aggregate gradation before and after compaction using conventional mechanical sieve analysis, and the nondestructive X-ray computed tomography (CT). The findings of this study lead to the development of an approach for the evaluation of aggregate resistance to degradation in SMA. This approach measures aggregate degradation in terms of abrasion, breakage and loss of texture.

Probabilistic Life-Cycle Cost Optimization for Pavement Management at the Project-Level
Paper No. 06-1591
Authors: Dima Jawad and Kaan Ozbay
Abstract: Optimizing lifecycle cost of the Transportation Infrastructure is regarded as a strategic approach/target for achieving the sustainability of the infrastructure systems. In this paper, a lifecycle cost optimization model (LCCOM) for pavement management is presented. The model is developed for analysis at the project level. The objective of this LCCOM is to identify a lifecycle strategy that can bring about an optimum gain to society. In order to achieve this, the lifecycle cost optimization must be able to look at every feasible lifecycle strategy for the system, regardless of the infrastructure system under consideration. It must consider every possible impact from putting the system into operation, and it must account for the uncertainties existing in the assumptions column of the problem. This LCCOM was developed to tackle these prerequisites and is applied to pavement structures as a platform for constructing the model. The model is formulated as a mixed-integer non-linear optimization model that derives its analytical framework from the economic theory of lifecycle cost analysis. A distinct feature of the LCCOM is the pairing of genetic algorithms as a search tool for arriving at the optima with Monte Carlo simulations as a risk analysis technique. Applying the LCCOM using real-world data obtained from the New Jersey Department of Transportation's pavement management system verified the applicability of the model and demonstrated its utilities. The research presented in this paper supports project-level probabilistic cost optimization in infrastructure management and opens the door to further exploration of the potential of this approach in real-world decision-making.

Determining the Return on Long-Life Pavement Investments
Paper No. 06-0707
Authors: Ralph Haas, Susan Tighe, Lynne Cowe Falls
Abstract: It is becoming increasingly necessary in life cycle analysis (LCA) of infrastructure assets, including pavements, to take a longer term approach than in past, conventional practice. This is largely for reasons of ensuring sustainability and assessing the future impacts of today's decisions. Life cycle

analysis can be primarily in terms of life cycle cost analysis (LCCA) but can also include considerations of resource conservation, environmental impacts, energy balance, etc. In any case, a key question is what constitutes a reasonable time horizon for life cycle analysis. The suggestion is that it should involve short, medium and long term periods, in the order of 25, 50 and 100 years, respectively. Further, using this approach, it is possible to develop a context for LCA of likely and uncertain societal activities, including transportation, over the short, medium and long terms. Conventional LCCA is directed to comparing competing alternative investment strategies and can involve a range of stakeholders, from the elected level to the public at large to suppliers and consultants. Of the methods available, present worth of costs is almost exclusively the method used in the pavement field. However, when medium to longer term life cycle periods are involved, rate-of-return and cost-effectiveness formulations can be applicable and should be considered. A numerical example is provided which shows how an agency can determine the internal rate of return (IRR) for two investment alternatives involving different pavement designs and a life cycle period of 50 years. As well, a cost-effectiveness example is provided for a sidewalk network and again a life cycle period of 50 years which shows how the best investment alternative has been identified. Conventional LCCA for calculating present worth of costs will undoubtedly continue to be used in the pavement field as a primary tool. However, going beyond conventional LCCA and using a rate-of-return or cost-effectiveness formulation, especially for medium to longer term life cycle periods, should be given more consideration.